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WADC TECHNICAL REPORT 55-400

FIELD TEST OF FOIL PACK IN-FLIGHT FEEDING SYSTEM

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PROJECT No. 7156

WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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FOREWORD

The Foil Pack In-Flight Feeding System is a method of feeding freshly cooked hot meals aboard aircraft on long flights. It was developed in the Aero Medical Laboratory, Directorate of Research, Wright Air Development Center. This work was done under Project 7156, Flight and Survival Foods, Feeding Methods and Nutritional Requirements. Mr. Joshua Chatham and Lt Dorothy Ballentine, Aero Medical Laboratory; Major E. C. Holland, Air Materiel Command; Captain Bert Davis and Captain G. B. Schroering, Air Defense Command were instrumental in setting up and conducting this field test. Acknowledgement is also made to the numerous other individuals from Air Materiel Command, Air Defense Command, and Wright Air Development Center who have helped in this test.

The field test was conducted as a joint Air Materiel Command-Air Defense Command-Wright Air Development Center exercise at McClellan Air Force Base, California. Air Materiel Command furnished the kitchen support and studied the ground preparation and support aspects. Air Defense Command utilized the meals for feeding on routine reconnaissance flights aboard RC-121 Super-Constellation radar-installed aircraft over the Pacific Ocean and studied the flight aspects of utilization. Wright Air Development Center monitored the test and furnished technical assistance, instruction, equipment and the funds for subsistence items. This test was conducted from 18 September 1954 to 31 March 1955.

ABSTRACT

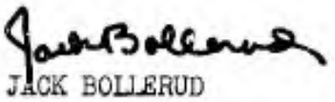
The Foil Pack In-Flight Feeding System is a method of feeding freshly cooked hot meals aboard aircraft on long flights. A field test of this feeding system was conducted as a joint Air Materiel Command-Air Defense Command-Wright Air Development Center exercise at McClellan Air Force Base, California. The Foil Pack meals were prepared in an Air Force dining hall operated by Air Materiel Command. These meals were served on RC-121 Super-Constellations assigned to the 8th Air Division, Air Defense Command on patrol over the Pacific Ocean from 18 September 1954 to 31 March 1955. During this period, a total of 8997 meals were prepared and served. In order to provide an accurate comparison between Foil Pack meals and Precooked Frozen meals, 1671 precooked frozen meals were also issued.

This field test showed that the Foil Pack In-Flight Feeding system is applicable to tactical operational usage. It also showed that these meals are economical, highly acceptable, and are preferred to other types of in-flight meals currently authorized.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:



JACK BOLLERUD
Colonel, USAF (MC)
Chief, Aero Medical Laboratory
Directorate of Research

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INTRODUCTION

This investigation was necessary to determine the requirements of integration with ground support and the applicability of the Foil Pack In-Flight Feeding System to tactical operational usage. During the field test, the system was used on operational flights supported by an operational kitchen without laboratory supervision or support.

Removal of a restriction against cooking aboard aircraft in 1951 paved the way for development of a feeding system involving in-flight cooking. The Strategic Air Command first demonstrated the possibility of cooking fresh foods in the B-4 type aircraft oven. SAC crew members at first cooked raw foods on sheets of aluminum foil placed directly on the shelves of the B-4 oven. The cooking of these foods could not be controlled as the foods were not covered and the uneven sheets were not in direct contact with the oven shelves. The Sac-Pac was developed in an attempt to overcome these difficulties. This was a soft aluminum foil sheet molded into a pan. This idea was submitted to the Aero Medical Laboratory and from it the Foil Pack In-Flight Feeding System was developed.

In this feeding system, raw and partially cooked foods are provided from Air Force kitchens for cooking in flight. Each food is placed in a separate aluminum foil container. A small amount of water and seasoning is added. The containers are refrigerated in flight until such time as the food is to be cooked. It is then transferred from the refrigerator to the aircraft oven, cooked, and served in the same disposable aluminum foil containers. Thus, freshly cooked hot meals can be supplied in the air without the need for a cook or a kitchen in the aircraft.

Larger, long range aircraft now in use require that more meals be eaten while aloft. The Foil Pack In-Flight Feeding System is intended to adequately and safely feed aircrews highly acceptable and nutritious meals while on routine operational flights with a minimum cost to aircraft in weight, space, and power. Such meals play an important role in aircrew efficiency and help prevent or minimize monotony and boredom which tend to occur during flights of long duration.

The purpose of this test was to determine the requirements of integration with ground support and the applicability of the Foil Pack In-Flight Feeding System to tactical operational usage.

METHOD OF APPROACH

Previous tests have shown that the Foil Pack Feeding System can function properly when the meals are prepared in the laboratory and served aboard aircraft by laboratory personnel. A limited functional suitability test was also conducted at Wright-Patterson Air Force Base during the period of 15 February to 15 May 1954. This earlier test gave a preliminary indication that the Foil Pack In-Flight Feeding System can function properly when meals are prepared in Air Force kitchens and cooked and served aloft by flight crews.

The meals used in this functional suitability test were prepared in an Air Force dining hall operated by Air Materiel Command at McClellan Air Force Base. The meals were served on RC-121 Super Constellations assigned to the 8th Air Division, Air Defense Command on patrol over the Pacific Ocean from 18 September 1954 to 31 March 1955. During this period a total of 8997 meals were prepared and served.

In order to provide an accurate comparison between Foil Pack meals and Precooked Frozen meals, 1671 Precooked Frozen meals were also issued. All meals were furnished to the aircrews free of charge so that cost would not bias evaluation by the aircrews.

Bacteriological studies of the Foil Pack meals were also conducted to evaluate the sanitary and public health aspects of this feeding system. Meals were selected at random each week and submitted to the Sixth Army Area Laboratory for bacteriological analysis.

Air Materiel Command reported on the following aspects: (1) Difficulties encountered in preparation of the meals; (2) Time required for preparation and delivery; (3) Cost; (4) Applicability of the system to tactical operational usage.

Air Defense Command reported on the following aspects: (1) Difficulties encountered in cooking and serving; (2) Deficiencies of food servicing equipment; (3) Acceptability; (4) Applicability of the system to tactical operational usage.

PROCEDURE

Foil Pack meals (Figure 1) were prepared in an Air Force dining hall at McClellan Air Force Base. During the first two weeks of the test, technical assistance was given by Lt Dorothy Ballentine of the Aero Medical Laboratory, Wright Air Development Center. Two airmen and a supervisor were familiarized with the necessary preparation procedures. These men thereafter continued daily preparation of the meals.

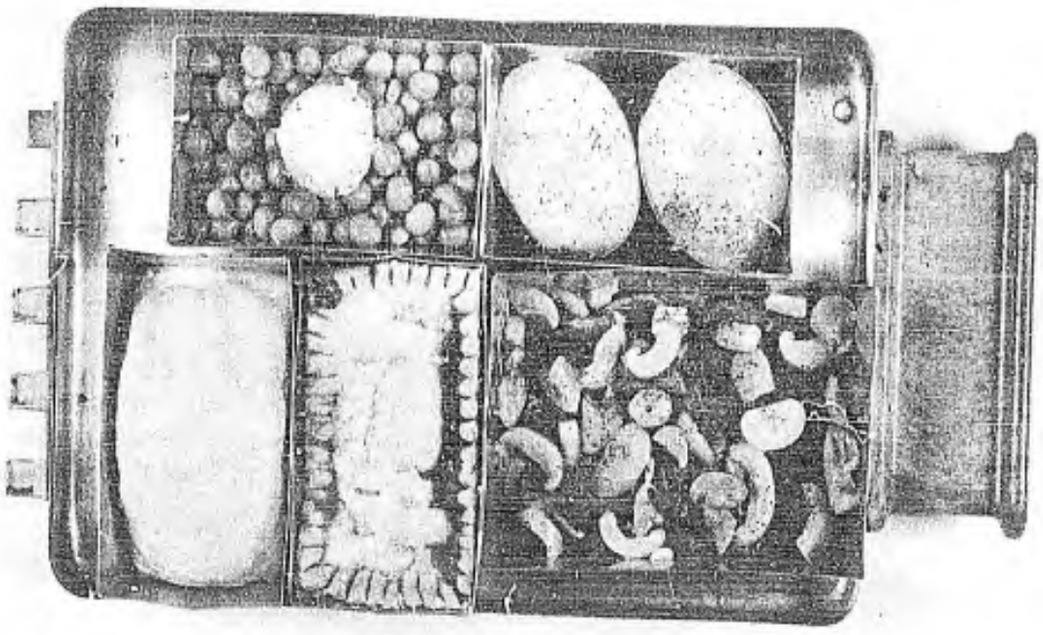

Figure 1. FOIL PACK MEAL ON B-4 OVEN TRAY BEFORE COOKING IN AIRCRAFT

The bacteriological studies, using a variety of menus, were performed weekly by Headquarters, Sixth Army Area Laboratory at Fort Baker and Oakland Army Base, California. The samples were refrigerated and analyzed between 8 and 24 hours and at 72 hours after preparation. Standard plate counts, coliform counts, and gram positive cocci counts were made on all samples.

Portable dry ice refrigerators accommodating 15 and 24 meals (Figure 2) were used throughout this test program for transporting the Foil Pack meals to the aircraft and also for storing the meals while in flight.

Figure 2. PORTABLE DRY ICE REFRIGERATOR

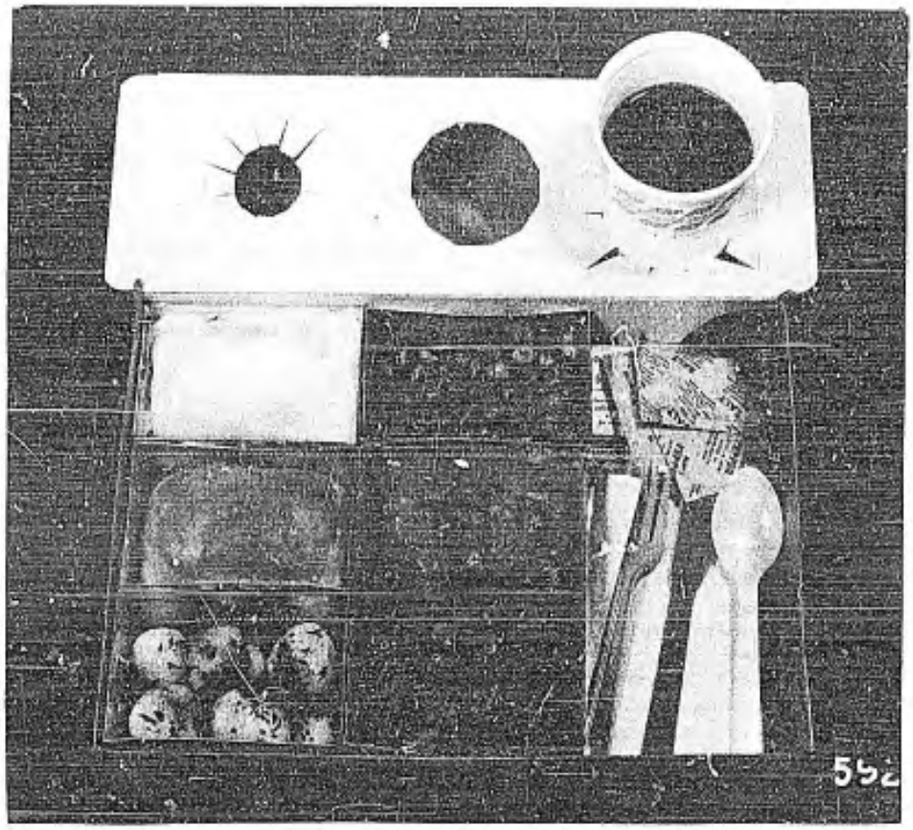

Figure 4. FOIL PACK MEAL ON DISPOSABLE LAP TRAY

An acceptability test of Foil Pack and Precooked Frozen meals was included in the field test. Crew members and passengers filled out a questionnaire (Figure 5) giving their reactions to the meals they had eaten. This report summarizes questionnaire data on a representative sampling of approximately 2000 of the Foil Pack meals and 450 of the Precooked Frozen meals. This questionnaire consisted of four parts: (1) A rating on a nine-point scale of like or dislike for each of the five components (meat, potato, vegetable, roll, and dessert); (2) A rating on a three point scale as to whether the portions served for each of the five components were satisfactory in size; (3) A rating on a three-point scale as to whether the total meal had satisfied hunger; and (4) An item indicating which was the more satisfactory meal, Foil Pack or Precooked Frozen. At the conclusion of the study, a second questionnaire (Figure 6) was filled out by the test participants. This questionnaire included a rating of the in-flight meal preferences based on experience accumulated during the test period and checked the findings of the first questionnaire for consistency of results.

FOIL PACK ACCEPTABILITY QUESTIONNAIRE

NAME	DATE	MENU NO.
RANK	AGE	WEIGHT
MILITARY SERVICE (Years)		
WHAT ARE YOUR DUTIES ABOARD THIS FLIGHT? (If none, indicate as PASSENGER)		
TOTAL MILITARY FLYING TIME (Hours)	HOURS SINCE LAST REGULAR MEAL	
SIZE OF LAST REGULAR MEAL ☐ Small ☐ Moderate ☐ Large		

A. Rate each meal component (meat, potato, vegetable, roll and dessert) by the appropriate scale below by circling the number under the words that most nearly describe how much you like or dislike the component.

I. Meat Component

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
1	2	3	4	5	6	7	8	9

II. Potato Component

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
1	2	3	4	5	6	7	8	9

III. Vegetable Component

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
1	2	3	4	5	6	7	8	9

IV. Roll Component

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
1	2	3	4	5	6	7	8	9

Figure 5. FOIL PACK ACCEPTABILITY QUESTIONNAIRE

FOLLOW-UP QUESTIONNAIRE ON
"IN-FLIGHT FEEDING"

1. Approximately how many Foil Pack meals have you consumed during this test? (Please circle)

   1-5 6-10 11-15 16-20 21-25 26-

2. What difficulties, if any, were encountered in storing, cooking or serving the meals?

   a.

   b.

   c.

   d.

   e.

3. What deficiencies, in general, were noted in the quality or quantity of this meal? (Foil Pack)

   a.

   b.

   c.

   d.

   e.

4. Generally speaking, what qualities did you particularly like about this meal?

   a.

   b.

   c.

   d.

   e.

During one phase of this test, Pre-cooked Frozen meals were issued for a comparative study with the Foil Pack meals.

Figure 5 Contd. FOIL PACK ACCEPTABILITY QUESTIONNAIRE

5. Approximately how many Pre-cooked Frozen meals (one tray, packed in a white cardboard box) did you consume? Please circle)

1-5 6-10 11-15 16-20 21-25 26-

6. What, if any, deficiencies did you find in the quality or quantity of this meal? (Pre-cooked Frozen)

a.

b.

c.

d.

e.

7. Generally speaking, which of the following menus did you particularly like or dislike?

a. Egg Omelet

b. Waffles

c. Beef Pot Roast

d. Chicken Pot Pie

e. Meat Balls & Spaghetti

f. Swiss Steak

g. Roast Turkey

h. Breast of Chicken

i. Beef Patty

j. Tenderloin Dinner

8. In your opinion, which feeding system would you prefer for continued operational use within the 8th Air Division (Please circle)

Foil Pack Pre-cooked Frozen Sandwich-type Box Lunch IF-5's

9. Briefly explain your above choice.

Figure 6. FOLLOW-UP QUESTIONNAIRE ON "IN-FLIGHT FEEDING"

V. Dessert Component

Dislike Extremely 1	Dislike Very Much 2	Dislike Moderately 3	Dislike Slightly 4	Neither Like Nor Dislike 5	Like Slightly 6	Like Moderately 7	Like Very Much 8	Like Extremely 9

B. Give your opinion of the portion sizes by checking the appropriate square for each component.

	TOO SMALL	ENOUGH	TOO LARGE
MEAT	☐	☐	☐
POTATO	☐	☐	☐
VEGETABLE	☐	☐	☐
ROLL	☐	☐	☐
DESSERT	☐	☐	☐

C. Please describe any off-flavors present, if any, for any of the components:

D. What is your reaction to this meal? (Place a check mark opposite the statement that most nearly describes your feeling)

Do you feel:

Too full (as if you had eaten too much)?

Satisfied with the meal (not too full or not still hungry)?

Still hungry (as though you had not eaten enough)?

E. Additional Comments

In your opinion, which was the more satisfactory meal, foil pack or frozen? Briefly give reason.

Figure 6 Contd. FOLLOW-UP QUESTIONNAIRE ON "IN-FLIGHT FEEDING"

DISCUSSION OF RESULTS

The simplicity of preparing Foil Pack meals appeals to food service personnel. The cooks experienced only a small degree of trouble the first few days; mainly in correct portion control and establishing an orderly production line procedure. After this period, the cooks were completely familiar with requirements and procedures and the complete preparation and assembly line speeded up considerably.

A total of 8997 Foil Pack meals were prepared during the test program and an account of the work hours was maintained. Two airmen prepared an average of 102 meals per day or 12.8 meals per hour. The airmen used an improvised area in the dining hall which had no ovens, ranges or mixers available for their immediate use. This resulted in a very inefficient production line system and numerous delays since routine troop feeding had priority over Foil Pack meal preparation. It is anticipated that preparation could be speeded up considerably in a flight kitchen designed for preparation of these meals.

The Foil Pack Feeding System provides an economical method of in-flight feeding. (Table I) During this test, the 8997 meals were prepared at an ingredient cost of $3,820.68 or an average of 42.5 cents per meal. This figure was determined by dividing the total project cost by the total number of meals produced during the test. This does not include the cost of accessories (containers, knife, fork, spoon and paperboard tray) which amounts to approximately 21.7 cents per meal. The complete cost therefore is approximately 64 cents. The cost of Foil Pack meals will undoubtedly decrease in the future as a result of more experience, better planning and increased volume. Troop issue items can be used whenever possible in place of the resale foodstuffs used in this test. These meals, prepared on the base where they are to be used, would involve a minimum of effort and expense. Present food service facilities could be utilized and little additional training would be involved.

The 1954 procurement of Precooked Frozen meals cost an average of 60.0 cents per meal. This figure was determined by dividing the total contract price of $189,263.93 by the total number of meals in the procurement (315,230).

The necessary supplements such as milk, salad, roll, butter and dessert required to complete each Precooked Frozen meal add another 15 to 17 cents per meal to the cost. The cost of the accessories (knife, fork, spoon and paperboard tray) amounts to approximately 8.8 cents per meal. The total cost of a Precooked Frozen meal, therefore, is approximately 84 cents. The low temperature transportation and storage costs which are not included in the statement would raise this cost considerably.

TABLE I

COMPARISON OF COST
FOIL PACK MEALS VS. PRECOOKED FROZEN MEALS

	Foil Pack	Precooked Frozen
Meal	42.5 cents	60.0 cents
Supplemental food items	included in cost of meal	15.0
Containers for meal	12.9	included with cost of meal
Knife, fork, spoon	3.8	3.8
Paperboard tray	5.0	5.0
Total	64.2	83.8

These figures do not include the cost of containers for precooked frozen meal supplements or transportation and storage costs for precooked frozen meals.

The average nutritive value of 15 Foil Pack meal menus randomly selected is indicated in Table II. One half pint of milk was included with this meal to raise the calcium and riboflavin content to recommended levels. These values are compared with the average nutritive value of Precooked Frozen meals with and without supplemental items and one third of the recommended daily minimum allowance as outlined in AF Regulation 160-95 "Nutrition." These meals should approximate one third of the day's recommended allowance. Foil Pack meals are nutritionally adequate. Precooked Frozen meals with recommended supplements are also adequate.

TABLE II

AVERAGE NUTRITIONAL VALUES

	Recommended Allowance	Foil Pack Meals	Precooked Frozen Meals	
			Without Supplement	With Supplement*
Calories	1000	1083	624	1133
Protein (gm)	33	39.8	28.7	38.2
Calcium (mg)	233	366	95	307
Vitamin A (I. U.)	1667	3438	1060	3190
Thiamine (mcg)	533	684	317	614
Riboflavin	733	844	374	753
Niacin (mg)	5.3	8.9	5.9	7.8
Ascorbic Acid (mg)	17	27	9	71

* Includes typical supplementary items consisting of tomato juice, salad, bread and butter, apple and coffee.

The results of the bacteriological study (Table III) showed that no health hazards are likely to occur provided routine procedures of preparation and storage are followed.

TABLE III

BACTERIOLOGICAL ANALYSES OF FOIL PACK MEALS
Logarithmic Average Bacteria Counts
of 23 Samples, 24 and 72 hours
After Preparation
7 December 1954 to 19 April 1955

	Meat	Vegetables	Potatoes
Standard Plate Count Per Gram			
24 hours after preparation	1500	1200	1500(1)
72 hours after preparation	2500(2)	1800(3)	2600(4)
Coliform Count Per 100 Grams			
24 hours after preparation	less than 10	less than 10	less than 10
72 hours after preparation	less than 10	less than 10	less than 10
Gram Positive Cocci Per Gram(5)			
24 hours after preparation	120	200	200(6)
72 hours after preparation	190	320(7)	330(8)

The results of analysis of one sample were SPC less than 3000, coliform and gram positive cocci negative. These results were unusually low and are not included.

All samples were held at 40°F after preparation.

(1) Includes the following high count: 200,000
(2) Includes the following high counts: 200,000, 62,000
(3) Includes the following high count: 110,000
(4) Includes the following high counts: 120,000, 98,000
(5) All cocci were coagulase negative
(6) Includes the following high count: 75,000
(7) Includes the following high count: 52,000
(8) Includes the following high count: 55,000

Evaluation of flight feeding equipment used in this test is reported separately.

The Foil Pack meals were shown to be highly acceptable and preferred to all other types of meals currently authorized. The mean ratings on a nine point scale of like and dislike (Table IV) were above seven. This rating is considered to be highly acceptable. The percentage indicating dislike was small.

TABLE IV

ACCEPTABILITY OF FOIL PACK MEALS

Menu Item	No. of Meals	Mean Rating	No. Indicating Dislike	Percent Dislike
Meat	1949	7.29	80	4.1%
Potato	1919	6.92	136	7.1
Veg.	1935	6.93	121	6.3
Roll	1938	7.64	21	1.1
Dessert	1911	7.09	75	3.9
Average	1930	7.17	87	4.5%

Source: Questionnaire - Figure 5

Table V shows the reaction of the respondents, based on a sample of 280 questionnaires, as to the adequacy of each of the five components:

TABLE V

ADEQUACY OF PORTION SIZE

Portion Size	Meat	Potato	Vegetable	Roll	Dessert
Too Small	28.9%	11.4%	16.9%	45.7%	9.3%
Just Enough	70.4	87.9	83.2	53.9	90.0
Too Large	0.7	0.7	0.0	0.4	0.7

Source: Questionnaire - Figure 5

Only a few considered the portions too large, whereas a fair percentage considered the portions of certain components too small. The vast majority of the respondents, however, considered the portions of each component "just enough."

Table VI summarizes the reactions to the meals in terms of satisfaction with the entire meal.

TABLE VI

ADEQUACY OF SIZE OF TOTAL MEAL

	Foil Pack		Precooked Frozen	
	No. of meals	%	No. of meals	%
Too full	9	0.5	3	0.7
Satisfied	1488	76.7	278	64.0
Still Hungry	443	22.8	153	35.3
Total	1940	100.0	434	100.0

Source: Questionnaire - Figure 5

Of a total of 1940 respondents who rated the Foil Pack meal, 76.7% reported that they were "satisfied" while 22.8% reported they were "still hungry". Of the 434 individuals rating the Precooked Frozen meal, 64.0% expressed satisfaction but 35.3% reported they were "still hungry." The Foil Pack and the Precooked Frozen meals were found to be satisfactory. A considerably higher percentage of individuals expressed greater satisfaction with the Foil Pack meal, however.

A study was carried out during the period of 17 January to 21 February 1955 to ascertain the relative preference for the Foil Pack versus the Precooked Frozen meals. During this period, the two types of meals were supplied to various crews. For example, on a given flight, each crew member was served one type of meal during the early part of the flight and the other type meal during a later period. The subjects were asked to state which type of meal they preferred. The data are summarized in Table VII.

TABLE VII

COMPARISON OF PREFERENCE
FOIL PACK VS. PRECOOKED FROZEN

	Prefer Foil Pack		Prefer Precooked Frozen	
	Number	%	Number	%
After eating Foil Pack	380	87.0	57	13.0
After eating Precooked Frozen	273	76.9	82	23.1
Total	653	82.4	139	17.6

Source: Questionnaire - Figure 5

As shown in the above table, the Foil Pack meals are decidedly favored over the Precooked Frozen meals. Of the 792 individuals who indicated preference, over 80% preferred the Foil Pack meals.

At the conclusion of the above study, the second in-flight questionnaire was filled out by 8th Air Division personnel who actively participated in the test program. The purpose was to determine the in-flight meal preferences based on experience accumulated during the test period, and to check the findings of the study reported above for consistency of results. Table VIII summarizes the questionnaire data collected from 4 to 7 April 1955 based on a sample of 152 cases.

The results of this questionnaire study confirmed the preference for the Foil Pack meals over the Precooked Frozen meals.

TABLE VIII

PREFERENCE FOR TYPES OF IN-FLIGHT MEALS

	Prefer Foil Pack		Prefer Precooked Frozen		Prefer Box Lunch	
	No.	%	No.	%	No.	%
Officers	37	84.1	7	15.9	0	0
NCO's	28	75.7	9	24.3	0	0
Airmen	46	64.8	8	11.3	17	23.9
Total	111	73.0	24	15.8	17	11.2

CONCLUSIONS

1. The Foil Pack In-Flight Feeding System is applicable to tactical operational usage.

2. Foil Pack meals are highly acceptable and are preferred to other types of in-flight meals currently authorized.

3. The Foil Pack Feeding System provides an economical system of in-flight feeding.

4. No health hazards are likely to occur provided routine procedures of preparation and storage of Foil Pack meals are followed.

5. Foil Pack meals are nutritionally adequate.

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